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Indian Standard

SPECIFICATION FOR TEMPERATURE CONTROL DEVICES FOR QUARTZ CRYSTAL UNITS (HEATING TYPE)

PART I GENERAL REQUIREMENTS AND TESTS

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 November 1970

Indian Standard

SPECIFICATION FOR TEMPERATURE CONTROL DEVICES FOR QUARTZ CRYSTAL UNITS (HEATING TYPE)

PART I GENERAL REQUIREMENTS AND TESTS

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SPECIFICATION FOR TEMPERATURE CONTROL DEVICES FOR QUARTZ CRYSTAL UNITS (HEATING TYPE)

PART I GENERAL REQUIREMENTS AND TESTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 13 February 1970, after the draft finalized by the Piezo-Electric and Magnetic Materials Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The object of this standard is to specify uniform requirements for electrical, mechanical and climatic properties of temperature control devices for quartz crystal units and to describe test methods.

0.3 There are three main types of temperature control devices which may be used for quartz crystal units (*see* **2.1**) and this standard covers only the Type 1 devices in which the temperature is kept relatively constant by heating alone.

0.4 In electronic circuitry, the same temperature control devices are used for many applications. It should be noted that this standard is restricted to the use with crystal units and that for other applications, the additional requirements and peculiarities should be taken into account.

0.5 The applicability of the tests to each type of temperature control device and the specific requirements for each test will be stated in the relevant specification for the individual temperature control devices. Should, however, any deviation exist between the provisions of this standard and those of the relevant individual specification, the provision of the latter shall prevail.

0.6 This standard requires reference to IS:589-1961* so far as the details of the climatic and mechanical testing procedures are concerned, only the relevant degrees of severities and the performance requirements have been specified in this standard.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

).7 In preparing this standard, assistance has been derived from the following documents:

IEC/TC 49(Central Office)32 Recommendations for temperature control devices for quartz crystals units, Section one: General characteristics and standards. International Electrotechnical Commission.

IEC/TC 49(Central Office)34 Recommendations for temperature control devices for quartz crystal units, Section two: Test conditions. International Electrotechnical Commission.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the results of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the general requirements and methods of test for judging the electrical, mechanical and climatic properties of temperature control devices (in which the temperature is kept relatively constant by heating alone) with fixed internal (crystal chamber) temperature for use with quartz crystal units. It includes the associated electronic/electrical circuits.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 General Terms

2.1.1 *Temperature Control Device for Crystal Units* (*TCD*) — A device for containing one or more crystal units which will maintain the temperature of crystal unit(s) relatively constant under various mechanical, electrical and climatic conditions.

NOTE — There are three main types of temperature control devices for quartz crystal units as specified below:

Type 1 Devices by which the temperature is kept relatively constant by heating alone.

Type 2 Devices by which the temperature is kept relatively constant by cooling alone.

Type 3 A combination of type 1 and type 2 above.

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*Rules for rounding off numerical values (*revised*).

2.1.2 *Crystal Chamber* — The cavity of the temperature control device, occupied by the crystal unit(s).

2.1.3 *Temperature Sensor* — The temperature sensing element required for automatic temperature regulation of the temperature control device. This may control the power input either directly or indirectly.

NOTE — The power control of a crystal oven may be either a switching device which supplies power intermittently to the heater, or a continuously varying device, which supplies power to the heater essentially proportional to the deviation of the crystal chamber temperature from its pre-set value.

2.1.4 *Crystal Oven* — Temperature control device in which the temperature is controlled by means of heating, to compensate for the heat loss from the device.

2.2 Operational Characteristics

2.2.1 *Crystal Chamber Temperature* — The instantaneous temperature existing at the location of the crystal vibrator.

2.2.2 *Mean Crystal Chamber Temperature* — The average between the minimum and maximum crystal chamber temperature when temperature control device is operated under constant operating conditions.

2.2.3 *Nominal Crystal Chamber Temperature* — The specified mean crystal chamber temperature when the device is operated at 27°C and at the rated voltage.

2.2.4 *Calibration Tolerance (on Temperature)* — The permissible deviation of the mean crystal chamber temperature from the nominal crystal chamber temperature measured at 27°C and at rated voltage.

2.2.5 *Ageing Tolerances (on Temperature)* — The tolerance allowed for a change of the mean crystal chamber temperature within a stated period of time when measured at 27°C and at rated voltage.

2.2.6 *Temperature Ripple* — The difference between maximum and minimum crystal chamber temperature when the temperature control device is operated at constant voltage and at 27°C after the mean crystal chamber temperature has become stable.

2.2.7 *Rate of Change of Crystal Chamber Temperature* — The quotient of the change of crystal chamber temperature and the time, for very short times, when the temperature control device is operated at constant voltage and at 27°C after the mean crystal chamber temperature has become stable.

2.2.8 *Variation of the Mean Crystal Chamber Temperature Over the Operating Temperature Range* — The difference between the maximum and minimum mean crystal chamber temperature over the operating temperature range measured under steady state conditions.

2.2.9 *Reduction Factor* — The ratio of change of ambient temperature to the corresponding change of mean crystal chamber temperature for specified changes of ambient temperature within the operating range.

2.2.10 *Overshoot/Undershoot* — That part of the transient change of the mean crystal chamber temperature which exceeds the limit values of the two steady states of the mean crystal chamber temperature before and after a comparatively rapid stated change in the operating condition(s) of the TCD (*see* Fig. 1).

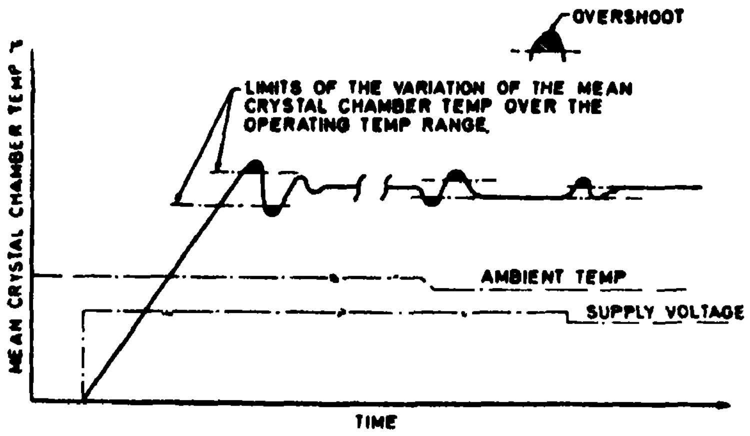

FIG. 1 LIMITS OF THE VARIATION OF THE MEAN CRYSTAL CHAMBER TEMPERATURE

2.2.11 *Switching Rate* — The frequency of the switching cycle measured at a specified ambient temperature after the mean crystal chamber temperature has become stable (for TCD's with ON/OFF control only).

2.2.12 *Switching Period* — The mean time for one switching cycle measured at a specified ambient temperature after the mean crystal chamber temperature has become stable (for TCD's with ON/OFF control only).

2.2.13 *Duty Cycle* — The ratio of the heating period to the switching period measured at the rated voltage and at specified ambient temperature (for TCD's with ON/OFF control only).

NOTE — Both the switching rate and the duty cycle vary with the ambient temperature.

2.2.14 *Warm-Up Time* — The time elapsed between the moment the temperature control device is switched on at the low limit supply voltage and the moment the crystal chamber temperature reaches and remains within the specified limits for mean crystal chamber temperature, ripple, rate of change, etc, when the device is operated at a specified ambient temperature within the operating temperature range.

2.2.15 *Maximum Power* — The maximum input power that the temperature control device consumes at rated voltage and at the minimum operating temperature.

2.2.16 *Average Power* — The power consumed by the temperature control device when it is operated at rated voltage and at a specified ambient temperature within the operating temperature range averaged over a sufficiently long time after the warm-up period.

2.2.17 *Over Temperature* — The difference between the mean crystal chamber temperature and the ambient temperature.

2.2.18 *Heat Loss Per Degree Celsius Over Temperature* — The average power consumed by the temperature control device divided by the difference of the mean crystal chamber temperature and the ambient temperature.

2.3 Conditions of Use

2.3.1 *Operating Temperature Range* — The range of operating temperatures over which the temperature control device will function within the specified tolerances.

2.3.2 *Storage Temperature Range* — The range of ambient temperature over which the temperature control device may be stored, handled and transported and thereafter still perform its correct operational function within its specified ratings.

2.4 Type — A type comprises TCD's having similar design feature, manufactured by the same techniques, and falling within the manufacturer's usual range of ratings for these devices.

NOTE 1 — Mounting accessories are ignored, provided they have no significant effect on the test results.

NOTE 2 — Ratings cover the combination of (a) operational properties, (b) electrical ratings, (c) sizes, and (d) environmental group.

2.4.1 *Type Tests* — Tests carried out to prove conformity with the requirements of this standard. These are intended to check the general qualities and design of a given type of temperature control device.

2.5 Acceptance Tests — Tests carried out on samples selected from a lot for the purpose of acceptance of the lot.

2.5.1 *Lot* — All TCD's of the same type, category and rating manufactured by the same factory during the same period, using the same process and materials.

2.6 Routine Tests — Tests carried out on each temperature control device to check the requirements which are likely to vary during production.

3. STANDARD VALUES AND TOLERANCES

3.1 Nominal Crystal Chamber Temperature — The nominal crystal chamber temperature shall be one of the following:

50, 55, 60, 65, 70, 75, 80, and 85°C

NOTE — When considering additions or modifications to the above temperatures, the temperatures listed in IS : 2916-1969* should be considered.

3.2 Tolerance on the Crystal Chamber Temperature — The preferred tolerances on crystal chamber temperature shall be one of the following:

± 0·01, ± 0·02, ± 0·05, ± 0·1, ± 0·2, ± 0·5, ± 1, ± 2 and ± 5 deg celsius.

The values apply both to the total tolerance and to a partial tolerance (for example, calibration tolerance, ripple, ageing). In general the larger tolerances apply to the calibration and the smaller to partial tolerances.

3.3 Operating Temperature Range

3.3.1 *Upper Limit* — The upper limit of the operating temperature range is limited by the mean crystal chamber temperature. The difference between the upper limit of the operating temperature range and the mean crystal chamber temperature shall be not less than 5 deg C.

3.3.2 *Lower Limit* — The values for the lower limit of the operating temperature range shall be:

0, −10, −20, −30, −40, and −55°C

3.4 Rated Supply Voltage — The rated supply voltages shall be:

5, 6, 6·3, 12, 12·6, 20, 24, 28, 30, 48, 60, 100, 115, 125, 220, 230, 240 V dc or ac (rms)

3.4.1 *Tolerances on Rated Supply Voltage* — The tolerances on rated supply voltage shall be:

± 2, ± 5, ± 10, $^{+10}_{-15}$ and ± 20 percent

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*Specification for quartz crystal units used in oscillators : Part I General requirements and tests.

4. MATERIALS, CONSTRUCTION AND WORKMANSHIP

4.1 Materials — Materials used shall be such as to withstand the high temperature attained due to any accidental failure of the sensor element. Under these conditions, the materials shall not get permanently damaged, cause fire or emit smoke.

4.2 Construction — Unless otherwise specified, temperature control devices for crystal units with metal holders shall have earthing facilities of these holders. It shall be so constructed, that it is convenient for the user to open the oven for replacing or inserting crystal, temperature sensor, etc.

4.3 Workmanship — The temperature control device shall be manufactured in a thoroughly workmanlike manner and in accordance with good engineering practice.

5. MARKING

5.1 Each temperature control device shall have the following information clearly marked upon it:

a) Manufacturer's type number,

b) Rated voltage in dc or ac (rms),

c) Diagram of pin connections,

d) Nominal crystal chamber temperature in °C,

e) Serial number,

f) Maximum power consumption, and

g) Country of manufacture.

NOTE — There should be space for marking the frequency of the crystal(s) fitted into the temperature control device. When more than one crystal unit is fitted into the temperature control device, the spaces for marking of the crystal frequencies shall clearly show by some means which crystals are fitted in a given crystal position.

5.2 In addition to the above markings, the following particulars may also be supplied to obtain a complete definition of the temperature control device:

a) Number and type of quartz crystal units for which the TCD is intended,

b) Warm-up time, and

c) Type of control.

5.3 The temperature control device may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

6. TESTS

6.1 Classification of Tests

6.1.1 *Type Tests* — The procedure for type tests shall be in accordance with IS:2612-1965*. The minimum number of samples for type tests shall be 10 units of each type. The sequence of type tests shall be as given in Appendix A.

6.1.2 *Acceptance Tests* — The acceptance tests shall be carried out on a limited number of samples selected in accordance with the sampling procedure given in IS: 2612-1965* and which have passed the routine tests. Two groups of samples, one for non-destructive tests (group A) and the other for destructive tests (group B) shall be selected in accordance with Appendix B of IS:2612-1965* and the samples in each group shall be subjected to the following tests in the order given below:

Group A (For Non-destructive Tests)	*Group B (For Destructive Tests)*
a) General examination (**6.4.1**)	a) Mechanical tests (**6.4**)
b) Electrical tests (**6.3**)	b) Climatic tests (**6.6**)
c) Operating characteristics (**6.5**)	c) Endurance (**6.7**)
	d) Operation under faulty condition (**6.8**)

6.1.3 *Routine Tests* — The following tests shall constitute routine tests and shall be carried out on each temperature control device crystal.

a) General examination (**6.4.1**)

b) Dimensions (**6.4.2**)

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*Recommendation for type approval and sampling procedures for electronic components.

c) Insulation resistance (**6.3.4**)

d) Average power (**6.3.2**)

e) Warm-up time (**6.5.3**)

f) Check of switching action:

1) *For ON/OFF type* — After the warm-up has been reached and the oven stabilized, there shall be the switching ON and OFF of the heater element at regular intervals. This can be checked by monitoring heater current or by similar means.

2) *For continuous type* — After the warm-up has been reached and the oven stabilized, the current drawn by the oven will vary slightly, which can be monitored by an ammeter or by similar devices. This ensures that the temperature is being regulated.

6.2 General Conditions for Tests

6.2.1 *Selection of Samples* — The samples for testing shall be so selected as to be representative of each type, category and rating.

6.2.2 *Atmospheric Conditions for Testing* — Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions specified in IS : 589-1961*.

6.2.3 *Pre-conditioning* — Before measurements are made, the TCD's shall be stored at the measuring temperature for a time sufficient to allow the entire unit reach that temperature.

6.2.4 *Mounting* — Under consideration.

6.3 Electrical Tests

6.3.1 *Maximum Power* — The temperature control device shall be brought to the lowest specified operating temperature, and kept at that temperature until thermal equilibrium is obtained. Then the rated supply voltage is applied.

For temperature control devices with ON/OFF control, the input power is measured during the ON-period. And this shall not exceed the maximum power specified.

6.3.2 *Average Power* — The temperature control device is brought to the specified operating temperature, and kept at that temperature until thermal equilibrium has been reached. The rated supply voltage is applied.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

The input power shall be recorded and averaged over a sufficiently long time (for ON/OFF controlled temperature control devices over not less than 3 complete switching cycles).

The average power measured above shall not exceed the specified value.

6.3.3 *Voltage Proof (High Voltage)*

6.3.3.1 Before this measurement, the temperature control device shall be maintained at a specified operating temperature for a period sufficient to allow the mean crystal chamber temperature to stabilize.

At the instant of the test, the supply voltage should be disconnected. The measurement shall be made in each of the following connections:

a) Between metal case or frame and all ungrounded terminals connected together,

b) Between the heater and all related terminals connected together and all other terminals connected to the metal case or frame, and

c) Between all ungrounded terminals to each other.

NOTE 1 — Due care shall be exercised in the performance of this test as in certain temperature control devices the temperature sensor may be connected to the frame, and in other cases one end of the heater winding may be connected to a semiconductor device. In cases where one of these connections is present, then only the appropriate tests should be applied.

NOTE 2 — When these measurements are specified after one or more environmental tests, and the results should have to be compared to the results obtained before those tests, these measurements may be made on the unheated temperature control device both before and after those tests.

6.3.3.2 The test voltage specified below shall be applied for a minimum period of one minute between the parts specified in **6.3.3.1**:

350 V dc for connections (a) and (c) and in the case of low-voltage heaters also for connection (b) (*see* **6.3.3.1**).

$2U + 1500$ V rms with a minimum of 2 000 V rms at power-frequency for mains voltage heaters ($U =$ rated mains voltage) for connection (b) (*see* **6.3.3.1**).

NOTE — Low voltages include voltages up to and including 34 V peak.

There shall be no breakdown or flashover during the application of the test voltages.

6.3.4 *Insulation Resistance*

6.3.4.1 The provision of **6.3.3.1** shall apply.

6.3.4.2 A voltage of 100 ± 15 V is applied for one minute to the connections mentioned in (a), (b) and (c) of **6.3.3.1** and the insulation resistance is measured. It shall not be less than the value specified in the relevant specification.

This test is applied immediately after the voltage proof test.

6.3.5 *Capacitance* — The capacitance shall be measured using bridge or any other suitable method between the following:

a) Each two terminals of the temperature control device used for the connection of one crystal vibrator (or in the case of multi-electrode vibrators, each two connections which can be considered as belonging to a two-electrode vibrator); and

b) Each of these terminals and the remaining terminals connected to the metal case, frame or similar.

There shall be no crystal unit in the temperature control device.

The measurement is made at a frequency well below the resonance frequency of the connections.

The capacitance values shall comply with the requirements specified in the relevant specification.

6.3.6 *Inductance* — The two connections to each crystal vibrator (or, in the case of multi-electrode vibrators, the two connections which can be considered as belonging to a two-electrode vibrator) are short-circuited at the inside of the oven. The inductances between the corresponding terminals shall be measured.

The values shall comply with the requirements specified in the relevant specification.

6.3.7 *Resistance* — Using the same connections as described in **6.3.6**, the resistance is measured.

It shall not exceed the value specified in the relevant specification or 1 ohm, whichever is the greater.

6.4 Mechanical Tests

6.4.1 *General Examination* — The marking shall be in accordance with **5** and the finish shall be satisfactory.

6.4.2 *Dimension* — The dimensions of the temperature control device shall be checked and shall comply with those specified in the relevant specification.

6.4.3 *Soldering (Where Applicable)* — This test shall be carried out in accordance with **7·18** of IS : 589-1961*, to determine the ability of the terminations to wet easily and to check that the temperature control device is not damaged by the soldering process.

When this test is required by the relevant specification, it shall specify the method of test, that is, Method 1 or Method 2, size of the soldering bit in case of Method 2 and period of recovery, if necessary.

After this test, there shall be no sign of mechanical deterioration, loosening of parts, etc.

6.4.4 *Robustness of Termination*

6.4.4.1 *Tensile test* — This test shall be carried out in accordance with **7.19.1** of IS : 589-1961*. The loading weight shall be as specified in the relevant specification.

6.4.4.2 *Bend test* — This test shall be carried out in accordance with **7.19.2** of IS : 589-1961*. For tag terminations, two consecutive bends shall be applied in accordance with **7.19.2.3** of IS : 589-1961*.

6.4.4.3 *Torsion test on screw terminals* — This test shall be carried out in accordance with **7.19.4** of IS : 589-1961*.

When this test (robustness of termination) is required by the relevant specification the following details shall be specified:

a) Tests to be carried out;

b) Test conditions, such as values of the torques, etc; and

c) Deviation from the standard test method, if any.

After each of these tests, the temperature control device shall be visually examined. There shall be no mechanical damage or loosening of parts, etc.

6.4.5 *Vibration* — This test shall be carried out in accordance with **7.6** of IS : 589-1961* using appropriate degree of severity. The temperature control device shall be mounted as specified in **6.2.4**.

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*Basic climatic and mechanical durability test for electronic components (*revised*).

When this test is required by the relevant specification the following details shall be specified:

a) Severity of test;

b) Final measurements; and

c) Deviation from the standard test method, if any.

The temperature control device shall then be visually examined. There shall be no sign of deterioration.

6.4.6 *Bumping* — This test shall be carried out in accordance with **7.5.1** of IS : 589-1961* with the temperature control device suitably mounted on the table of a bump test machine.

The temperature control device shall then be visually examined. There shall be no fracture or loosening of parts or any other mechanical failure.

6.5 Operating Characteristics

6.5.1 *Crystal Chamber Temperature*

6.5.1.1 *Method A* — The temperature sensor used to measure the crystal chamber temperature shall preferably be a 10 ± 0·02 MHz calibrated AC cut crystal vibrator (*see* Appendix B). It shall be enclosed in a crystal holder of the same type that the temperature control device is intended to be used with. When the temperature control device is intended for more than one quartz crystal unit, one or more temperature sensors shall be placed in any of the sockets and dummy units shall be placed in each of the remaining sockets. In this case, the mean crystal chamber temperature is the mean of the readings at each location, and the variation is the difference in maximum and minimum crystal chamber temperatures found both in time and place. For the other quantities, the maximum or minimum as applicable, found for any location of the temperature sensor, is chosen.

Precautions: The following precautions shall be taken when measuring crystal chamber temperature by means of a calibrated crystal unit:

a) The maintaining oscillator network can be housed either inside or outside the environmental test chamber. In either case, due care should be taken so that the effect of temperature changes on the oscillator or changes in the parameters of the connecting leads between crystal and the oscillator do not unduly influence the measuring accuracy.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

b) The crystal drive level shall be maintained at a low and relatively constant value. This value should be stated.

c) The frequency measuring equipment used shall have a resolution consistent with the degree of accuracy required.

d) Each individual crystal unit shall be calibrated with its associated oscillator and connecting leads. The calibration of this combination shall be checked at a convenient temperature for every different type of temperature control device to be measured.

e) It shall be understood that the calibrated crystal unit, its maintaining oscillator and the frequency measuring equipment may all change with time. Therefore, any measurements to be conducted on temperature control device over a period of time should take into account the possible effect these changes may have on the results obtained.

f) It should be understood that a number of factors such as the diameter of the connecting wires, type of socket used, etc, are contributing factors to the overall temperature control device performance. Where necessary, these factors should be taken into account and specified in the relevant specification, if required.

6.5.1.2 *Method B (alternative method)* —The method consists of introducing a pre-calibrated bead thermistor inside the crystal oven at the point where the temperature and other parameters are to be measured. This is best achieved by mounting the bead thermistor in a 'dummy' crystal unit of the same holder type as the type of crystal intended for operation in the crystal oven. This is best achieved by mounting the thermistor on a crystal similar to the appropriate one shown in Appendix B.

The thermistor chosen should have a sufficient slope in its resistance/temperature characteristic, at least over the measuring temperature range, so that a high degree of resolution can be obtained. Most commercially available ones meet this requirement.

The first measurement is to calibrate the thermistor over the complete operating temperature range of crystal oven. This is done by keeping the sensor element inside a test chamber whose temperature can be varied as required. The dc resistance of the thermistor is measured, using a precision bridge of adequate accuracy, taking care to see the leads are sufficiently thick and short. The measurement shall be done quickly so that the resistance of the thermistor is not affected by the current which flows when the bridge is connected to it.

The calibrated thermistor is introduced in the crystal oven. To measure the temperature the dc resistance is measured and the temperature read off from the calibration curve.

6.5.2 *Maximum Power* — *See* **6.3.1**.

6.5.3 *Warm-Up Time* — The temperature control device is brought to the lowest specified operating temperature and kept at that temperature until thermal equilibrium inside the chamber has been reached as indicated by constant temperature inside the chamber. It is then connected to the lowest specified supply voltage, and the crystal chamber temperature is recorded (*see* **6.5.1**).

The time elapsed between the moment that the temperature control device is switched on at the low limit supply voltage, and the moment the crystal chamber temperature reaches and remains within the specified limits for mean crystal chamber temperature, ripple, rate of change, etc, shall be within the specified warm-up time.

6.5.4 *Average Power* — *See* **6.3.2**.

6.5.5 *Heat Loss per Degree Celsius Over-Temperature* — The heat loss per degree celsius over-temperature is calculated from the average power, and the difference between the crystal chamber temperature and the operating temperature.

6.5.6 *Switching Period (For TCD's with ON/OFF Control Only)*—After the mean crystal chamber temperature has become stable at a specified operating temperature, the mean duration of the switching cycle shall be measured over at least 3 switching cycles.

6.5.7 *Switching Rate*—The reciprocal value of the switching period measured in **6.5.6** gives the switching rate.

6.5.8 *Duty Cycle*—This measurement may be combined with those of switching period (*see* **6.5.6**). After the mean crystal chamber temperature has become stable at a specified operating temperature, the duration of one switching period and one heating period is measured.

The ratio of the heating period to the switching period is the duty cycle. This value shall be within the limits specified in the relevant specification.

6.5.9 *Crystal Chamber Temperature Characteristics at Fixed Operating Temperature*—The operating temperature shall be within the specified limits, and the supply voltage shall be kept at the rated value. The following measurements shall be made when the mean crystal chamber temperature has reached its thermal equilibrium.

The crystal chamber temperature characteristics shall be measured over a sufficiently long time (for ON/OFF controlled TCD's over not less than 3 complete switching cycles).

The measurements may be repeated for any condition specified in the relevant specification.

6.5.9.1 *Mean crystal chamber temperature*—Under the conditions specified above, the instantaneous crystal chamber temperatures shall be recorded (*see* **6.5.1**). From these values, the mean crystal chamber temperature shall be calculated which shall be within the specified limits.

6.5.9.2 *Temperature ripple*—From the measurements of mean crystal chamber temperature, the difference between the maximum and minimum values gives the temperature ripple. This value shall be within the specified limits.

6.5.9.3 *Rate of change of crystal chamber temperature*—From the measurements of mean crystal chamber temperature, the maximum value of the quotient of the change of crystal chamber temperature to the elapsed time for a time interval consistent with the measurement accuracy required is calculated and shall be within the specified limits.

6.5.10 *Variation of Mean Crystal Chamber Temperature Over the Operating Temperature Range*—The temperature control device is brought to the lowest specified operating temperature, and kept at that temperature until thermal equilibrium has been reached as indicated by constant temperature inside the chamber. The supply voltage is kept at the rated value. The operating temperature is then raised in steps not greater than 10°C ambient and the chamber allowed to attain thermal equilibrium. Mean crystal chamber temperature shall be recorded at each step.

The variation of the mean crystal chamber temperature shall not exceed the value specified in the relevant specification. The measurement may be repeated for any other supply voltage as specified in the relevant specification.

6.5.11 *Reduction Factor*—This factor can be derived from the measurement of **6.5.10**. It shall be within the limits specified in the relevant specification.

NOTE — The recorded temperature characteristics is not expected to be linear. Therefore care shall be taken that this factor is related to such a temperature interval as to obtain the minimum value.

6.5.12 *Overshoot/Undershoot*—The operating temperature shall be within the specified limits and the supply voltage is kept at the rated value.

Before the measurement starts, the crystal chamber temperature should have reached thermal equilibrium. A comparatively rapid stated change of an operating condition, such as operating temperature or supply voltage, may cause a transient change of the mean crystal chamber temperature. This shall be recorded (*see* **6.5.1**). It shall be within the limits specified in the relevant specification.

6.5.13 *Signalling Devices*—During all these measurements, the signalling devices, if any, shall function as specified in the relevant individual specification.

6.6 Climatic Tests

6.6.1 *Climatic Sequence*

6.6.1.1 *Dry heat*—This test shall be carried out in accordance with **7.2** of IS : 589-1961* at the upper temperature of the operating/operable temperature range of the crystal unit.

After recovery, the temperature control device shall be visually examined. There shall be no visible damage.

6.6.1.2 *Damp heat (accelerated) first cycle*—This test shall be carried out in accordance with **7.4** of IS : 589-1961* for one cycle.

After recovery, the temperature control device shall be visually examined. There shall be no visible damage.

After this test, the temperature control device shall be immediately subjected to cold test.

6.6.1.3 *Cold*—This test shall be carried out in accordance with in **7.1** of IS : 589-1961* at the lower temperature of operating/operable temperature range of the crystal unit.

After recovery, the temperature control device shall be visually examined. There shall be no visible damage.

6.6.1.4 *Low air pressure*—This test shall be carried out in accordance with **7.12** of IS : 589-1961* using appropriate degree of severity as specified in the relevant specification.

6.6.1.5 *Damp heat (accelerated) remaining cycles*—This test shall be carried out in accordance with **7.4** of IS : 589-1961* for the remaining number of cycles as specified in the relevant specification.

After recovery, the temperature control device shall be visually examined. There shall be no visible damage.

When this test is specified by the relevant specification, the minimum value of the insulation resistance shall also be specified.

6.6.2 *Rapid Change of Temperature*—This test shall be carried out in accordance with **7.14** of IS : 589-1961* using appropriate degree of severity as specified in the relevant specification.

The temperature control device shall then be visually examined. There shall be no visible damage.

6.6.3 *Damp Heat (Long Term Exposure)*—This test shall be carried out in accordance with **7.3** of IS : 589-1961* using the appropriate degree of severity as specified in the individual specification.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

After recovery, the temperature control device shall be visually examined. There shall be no visible damage.

When this test is specified in the relevant specification, the minimum value of the insulation resistance shall also be specified.

6.7 Endurance

6.7.1 *Standard Ambient Test*—The temperature control device is subjected to intermittent operation for a total period of 1 000 hours under the standard atmospheric conditions for testing.

Each operational cycle consists of one hour rated supply voltage connected to the temperature control device and half-an-hour voltage disconnected from the temperature control device.

After 250, 500, 750 hours and at the end of the test, the operational characteristics of the temperature control devices are measured according to **6.3.3** to **6.3.7** and **6.5**. They shall comply with the requirements specified in the relevant specification.

6.7.2 *Cold Storage Test* — The temperature control device is maintained at the lower storage temperature specified in the relevant specification for a minimum period of 24 hours. After this period, the temperature control device shall be tested as described in **6.5.9** and the mean crystal chamber temperature shall be within the limits specified in the relevant specification.

6.7.3 *Hot Storage Test* — The temperature control device is maintained at the upper storage temperature specified in the relevant specification for a minimum period of 24 hours. After this period, the temperature control device shall be tested as described in **6.5.9**, the mean crystal chamber temperature shall be within the limits specified in the relevant specification.

6.8 Operation Under Fault Condition — The control device of the crystal oven is short-circuited, blocked or otherwise impaired so that the maximum power is continuously delivered to the heater when the crystal oven is connected to the supply voltage.

The crystal oven is operated at the upper limit of supply voltage, and at maximum operating temperature until a safety device, if any, operates or until the external surface temperature of the crystal oven has become stable.

During this test, no fire or smoke shall emanate from the crystal oven. The external surface temperature shall not exceed the value specified in the relevant specification.

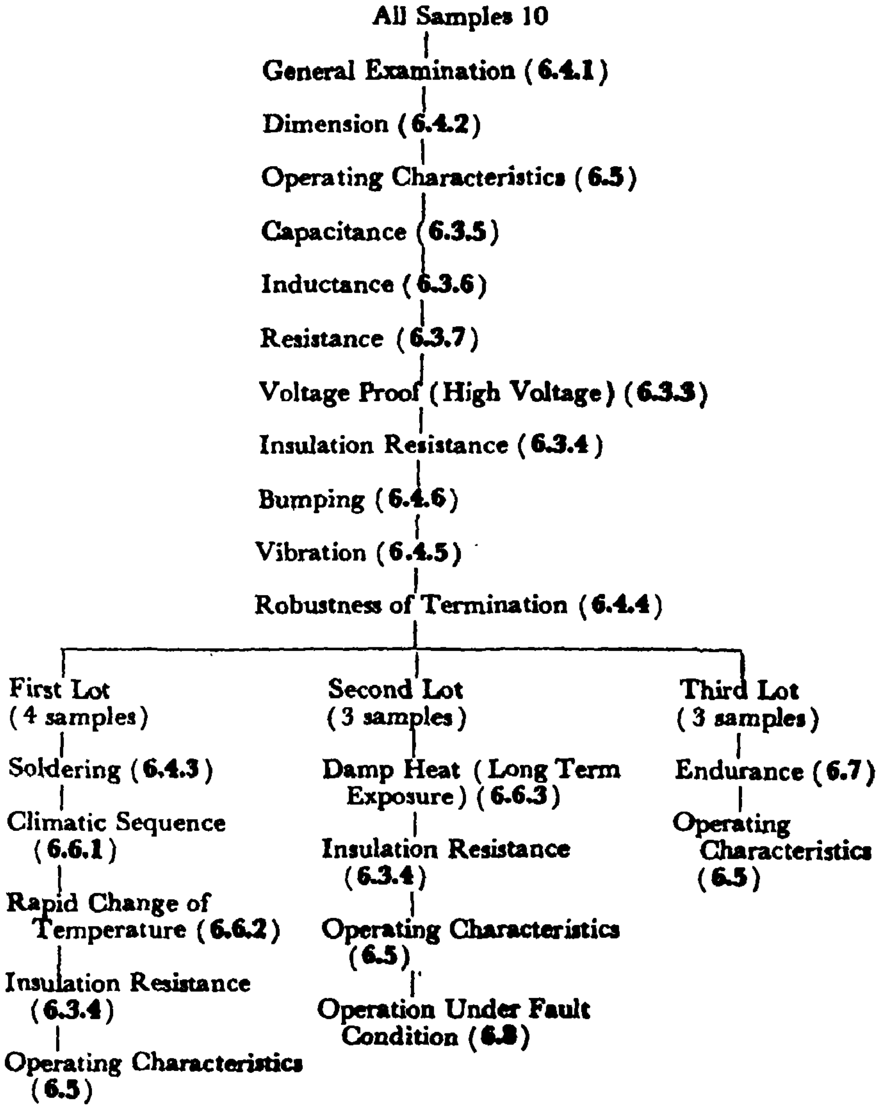
For crystal ovens with restorable safety device, this test may be repeated several times.

Note — For crystal ovens with safety device, the maximum surface temperature will occur some time after the safety device has operated

APPENDIX A

(*Clause* 6.1.1)

SCHEDULE OF TYPE TESTS


All Samples 10
General Examination (6.4.1)
Dimension (6.4.2)
Operating Characteristics (6.5)
Capacitance (6.3.5)
Inductance (6.3.6)
Resistance (6.3.7)
Voltage Proof (High Voltage) (6.3.3)
Insulation Resistance (6.3.4)
Bumping (6.4.6)
Vibration (6.4.5)
Robustness of Termination (6.4.4)
First Lot (4 samples)
Soldering (6.4.3)
Climatic Sequence (6.6.1)
Rapid Change of Temperature (6.6.2)
Insulation Resistance (6.3.4)
Operating Characteristics (6.5)
Second Lot (3 samples)
Damp Heat (Long Term Exposure) (6.6.3)
Insulation Resistance (6.3.4)
Operating Characteristics (6.5)
Operation Under Fault Condition (6.8)
Third Lot (3 samples)
Endurance (6.7)
Operating Characteristics (6.5)

APPENDIX B

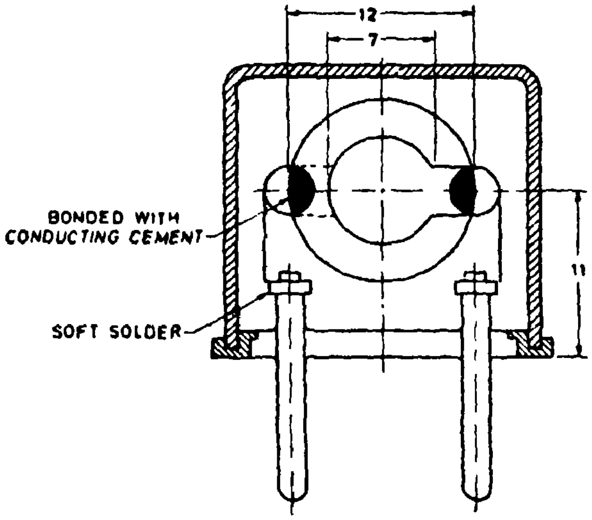
(*Clause* 6.5.1)

DETAILS OF CALIBRATED AC CUT MEASURING CRYSTALS

B-1. CRYSTALS IN TYPE AA HOLDER

B-1.1 The details of AC cut measuring crystals in type AA holder shall be as follows:

a) Angle of cut	30° 30′ ± 5′
b) Blank diameter	12 mm
c) Surface finish	Finish with Al_2O_3; approximately 3 000 mesh lapped to 10·200 MHz and etched for 1 minute in saturated ammonium bifluoride.
d) Electrode diameter	7 mm
e) Electrode material	Gold
f) Total plate back frequency	200 KHz approximately
g) Assembly details	*see* Fig. 2
h) Unit to be filled with dry nitrogen	



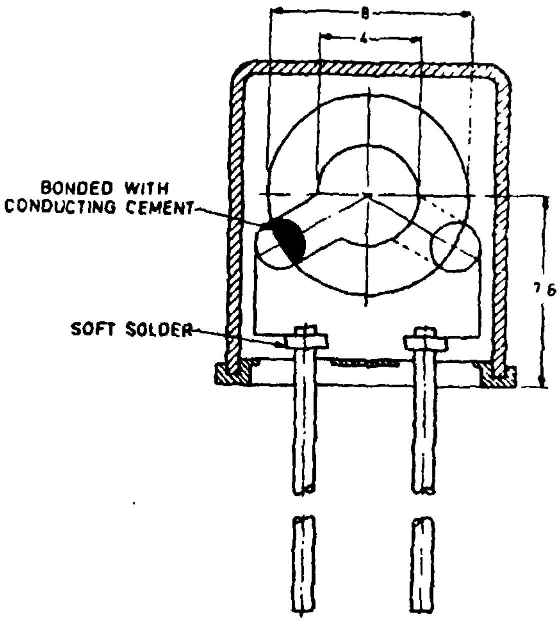
All dimensions in millimetres.

NOTE — All crystal mounting springs to be 0·155 mm dia music wire.

FIG. 2 TYPE AA HOLDER

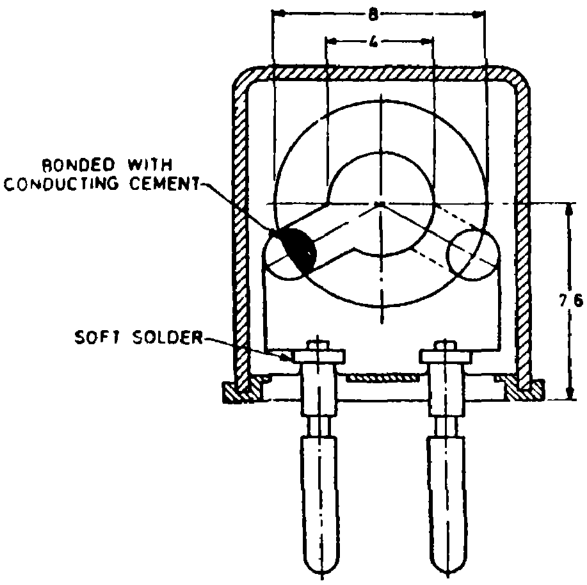
B-2. DETAILS OF CRYSTALS IN TYPE BC AND HC25U (Style K) HOLDERS

a) Angle of cut	30° 30′ ± 5′
b) Blank diameter	8 mm, bevelled on both sides, 24 diopter, 0·5 mm wide after finish lapping
c) Surface finish	Finish with Al_2O_3; approximately 3 000 mesh lapped to 10·100 MHz and etched for 1 minute in saturated ammonium bifluoride.
d) Electrode diameter	4 mm, tabs at 120°
e) Electrode material	Gold
f) Total plate back frequency	100 kHz
g) Assembly details	See Fig. 3 and 4
h) Units to be filled with dry nitrogen.	



All dimensions in millimetres.

FIG. 3 TYPE BC HOLDER



All dimensions in millimetres.

FIG. 4 TYPE HC25U (STYLE K) HOLDER

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